How defoliation frequency acts on N2O emission in grasslands?

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Context

- In agricultural sector, 46% of N_2O is emitted by soil through microbial activity: denitrification and nitrification (IPCC 2007).

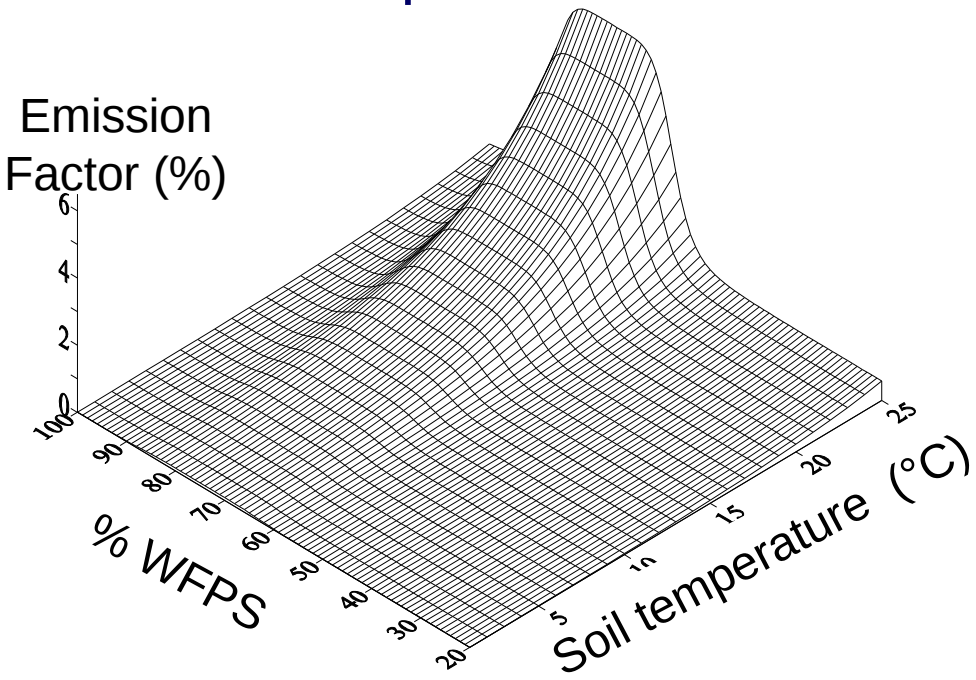
- Global N_2O emissions are estimated to increase at a rate of 0.25% per year (IPCC, 2001)

- Soil management strategies may reduce emissions by 10 to 30%.

Grassland : at local scale N_2O emissions depend on

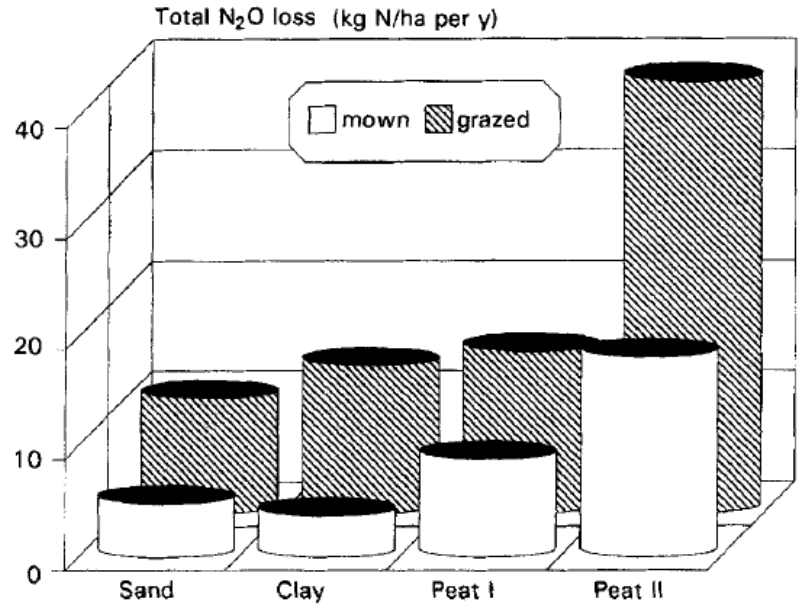
Environmental parameters and management

N supply, water filled pore space and soil temperature



Flechard et al. 2007 AGEE

Soil texture and management

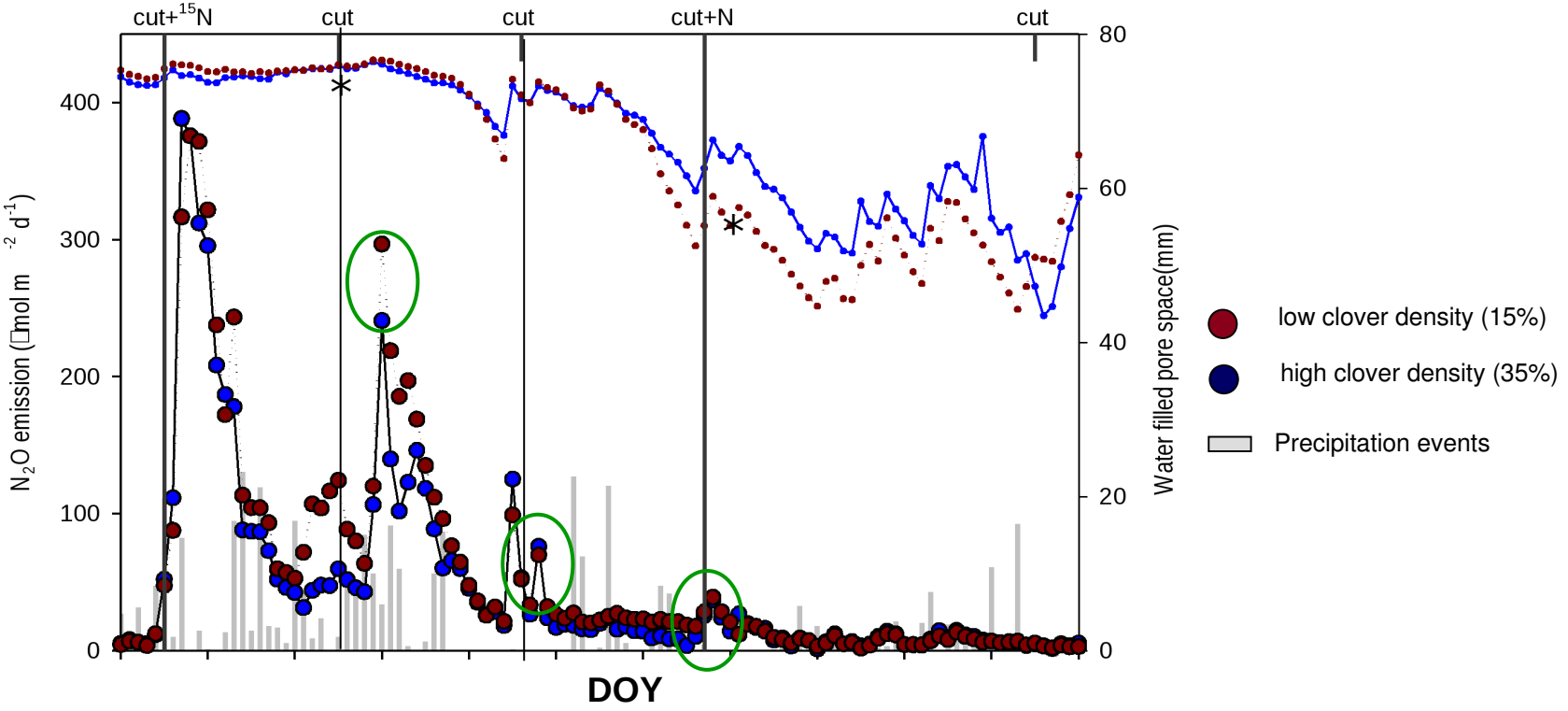


Velthof et al. 1996

Grassland : N_2O emissions depend on

Management and community structure

- Clover density and defoliation



- N_2O emissions ↗ with **low clover** content
- competition plant/microbs for N depending on clover density

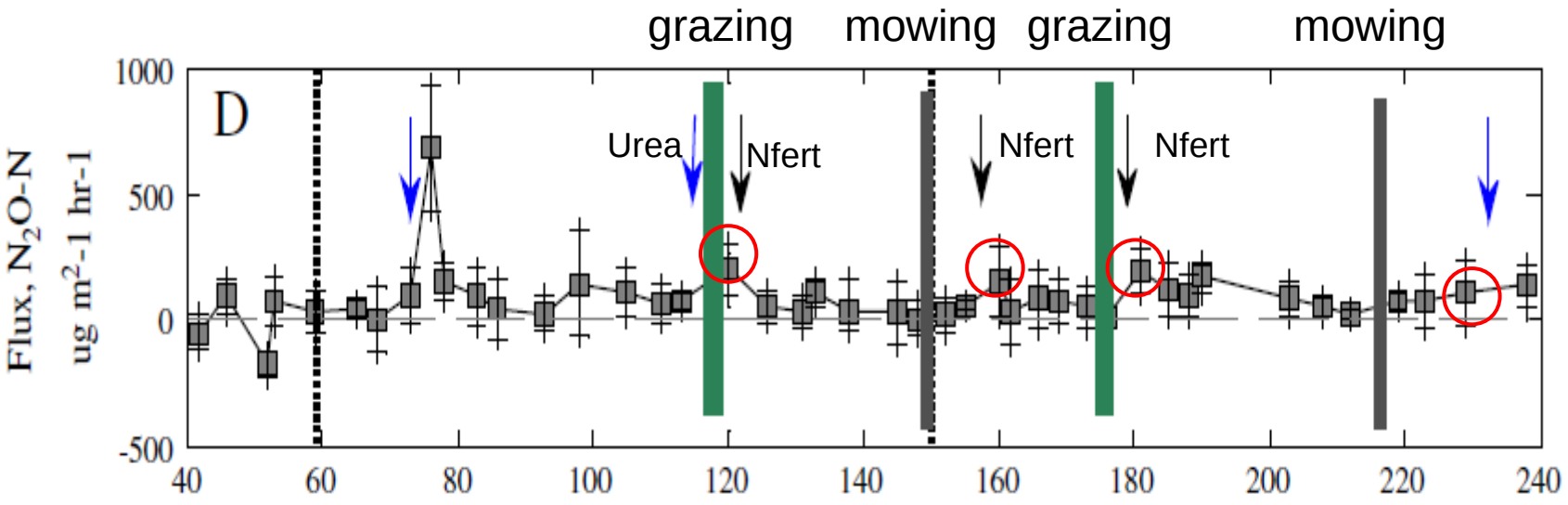
- N_2O emissions peak at after cuts

(Klumpp & Bloor et al. 2010)

Grassland : N_2O emissions depend on

Management and N supply

- Grazing and mowing events and N supply



However, N_2O emissions are difficult to ascribe to defolation events as other variables favouring emissions coincident (e.g. Tsoil, WFPS, Nfert).

Rafique et al. (2012)

Grassland : N_2O emissions depend on

Management and nutrient availability

- **C supply/availability**

Denitrification-derived N_2O is triggered by organic matter with high labile C content (Senbayram et al. 2012)

Cutting-induced flushes in plant rhizodeposition and soil C availability may modify microbial activity (Ostle et al. 2007).

OBJECTIVES

In a field experiment we tested following hypothesis

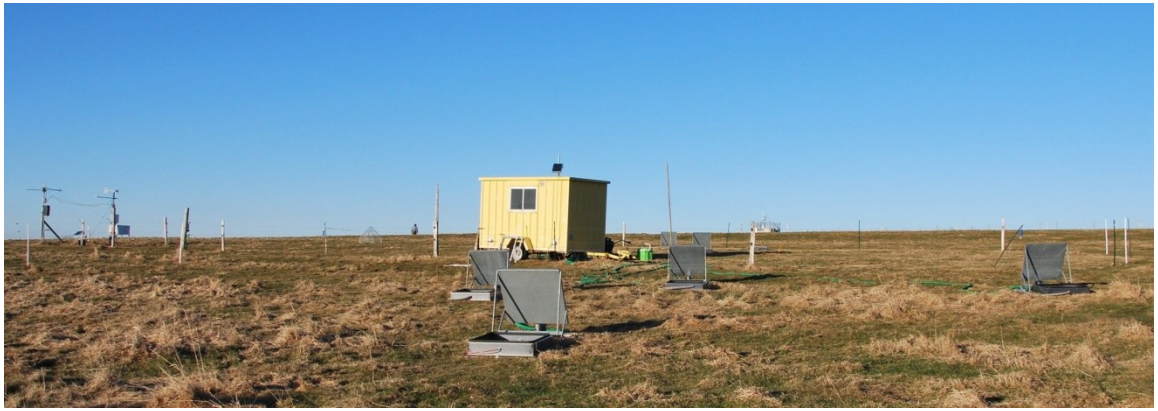
(i) High defoliation frequency will increase N_2O emissions (ext vs int) and

(ii) High defoliation enhances denitrifier activity by an potential increase in labile C (i.e. rhizodeposition (exudation, roots death) for microbes.

Permanent upland grassland site F-Laqueuille

Alt. 1050m, mean T 8°C, 1000mm

8 automated chambers +IRGA to measure
continuously (6times d^{-1}) N_2O, Hsoil and Tsoil



<u>Management</u>

1.2 LSU ha.yr-1

210 g N ha.yr-1 (3 splits)

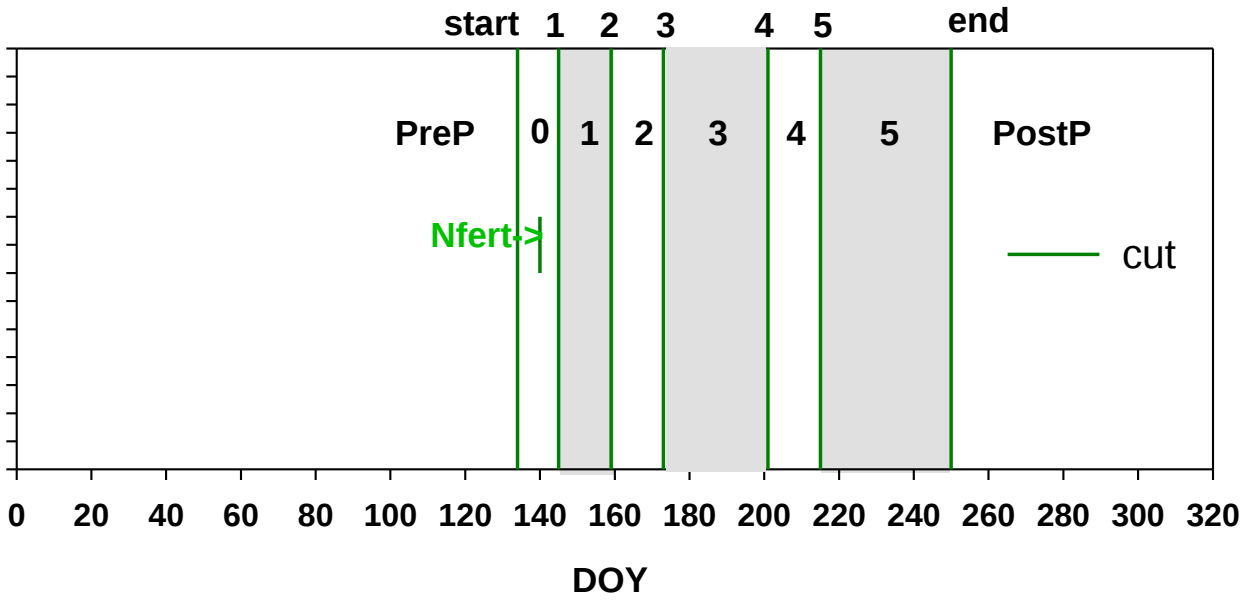
13.7 % clover

7 dominante species (36)

Prod: 7.1t DM green.ha.yr-1

Standing: 2.6t DM.ha.yr-1

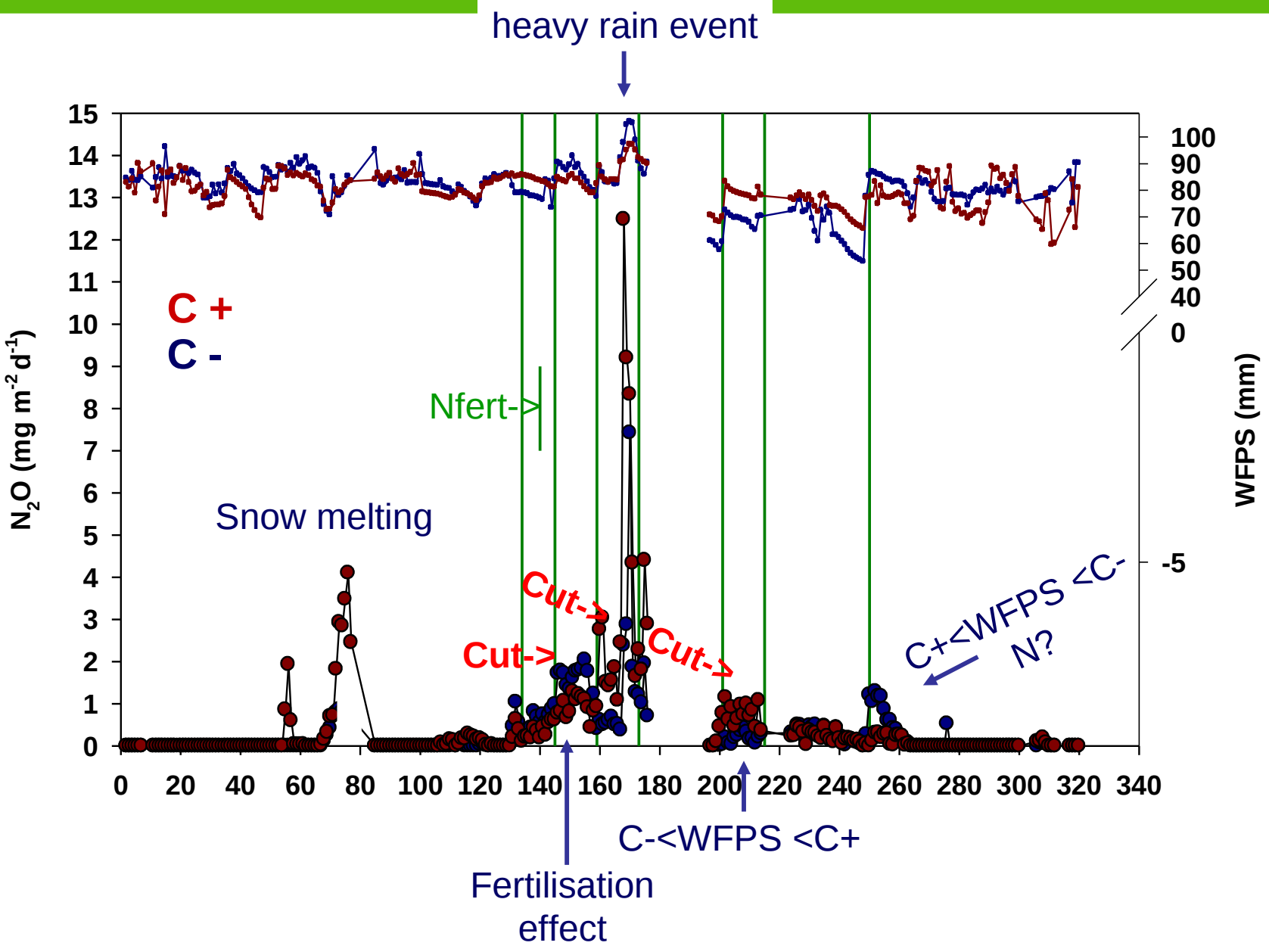
Experimental Setup



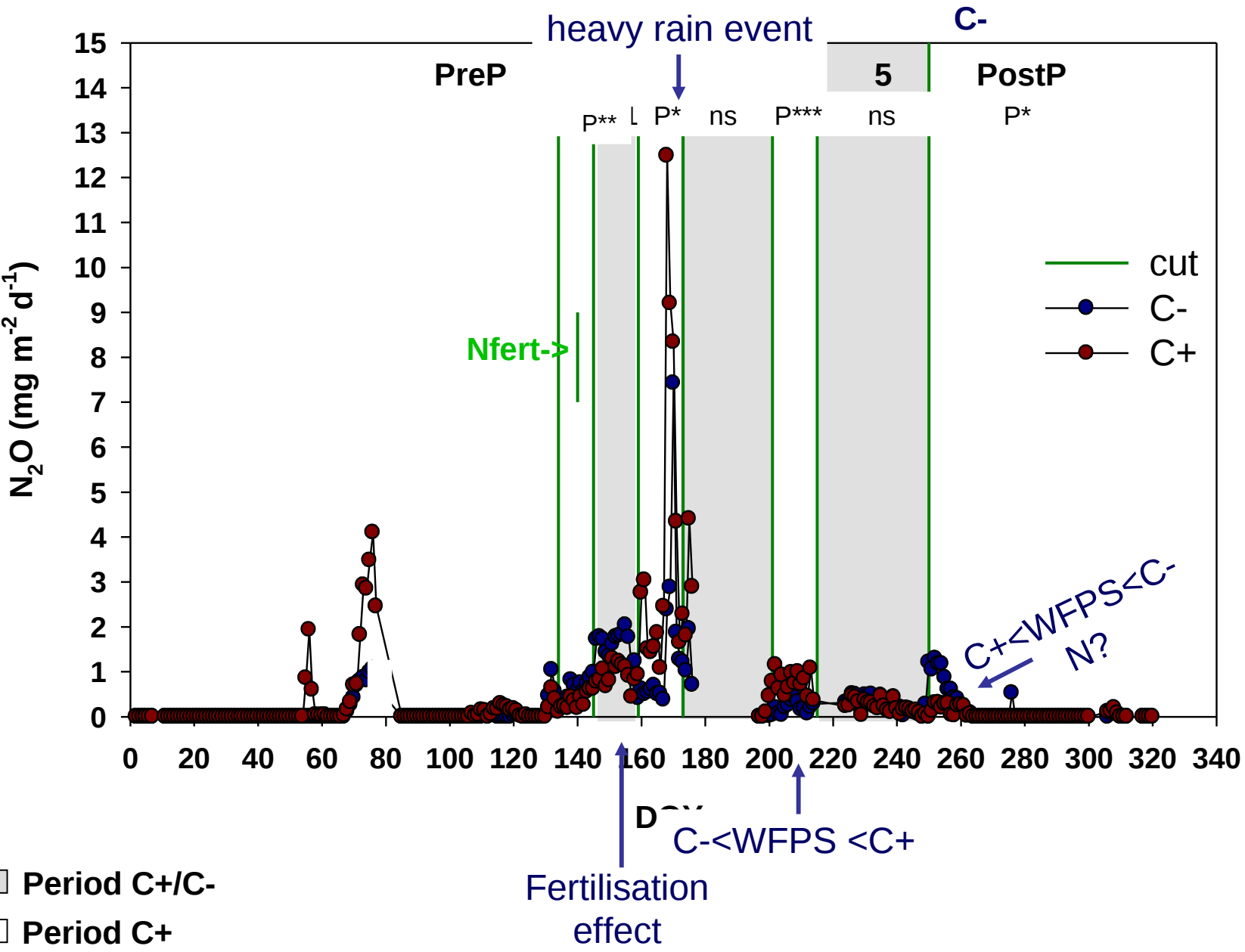
At cutting dates :

- aboveground biomass, litter and stubble mass
- % clover
- Potential nitrification and denitrification activity (after 3 days)
- pH, NH_4 and NO_3 contents

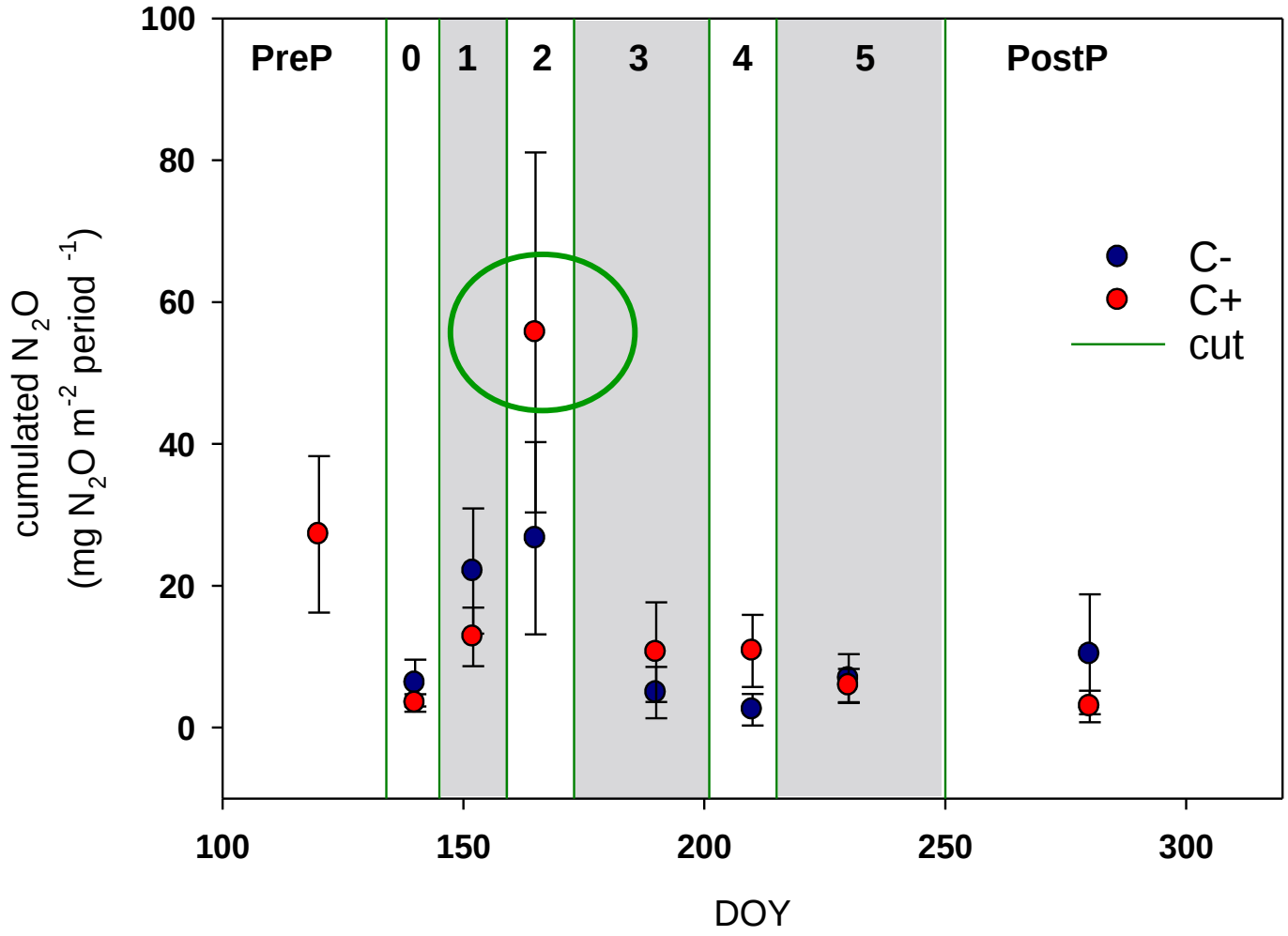
Results: daily N_2O



Results: daily N_2O



Results: cumulated N_2O over the cutting period



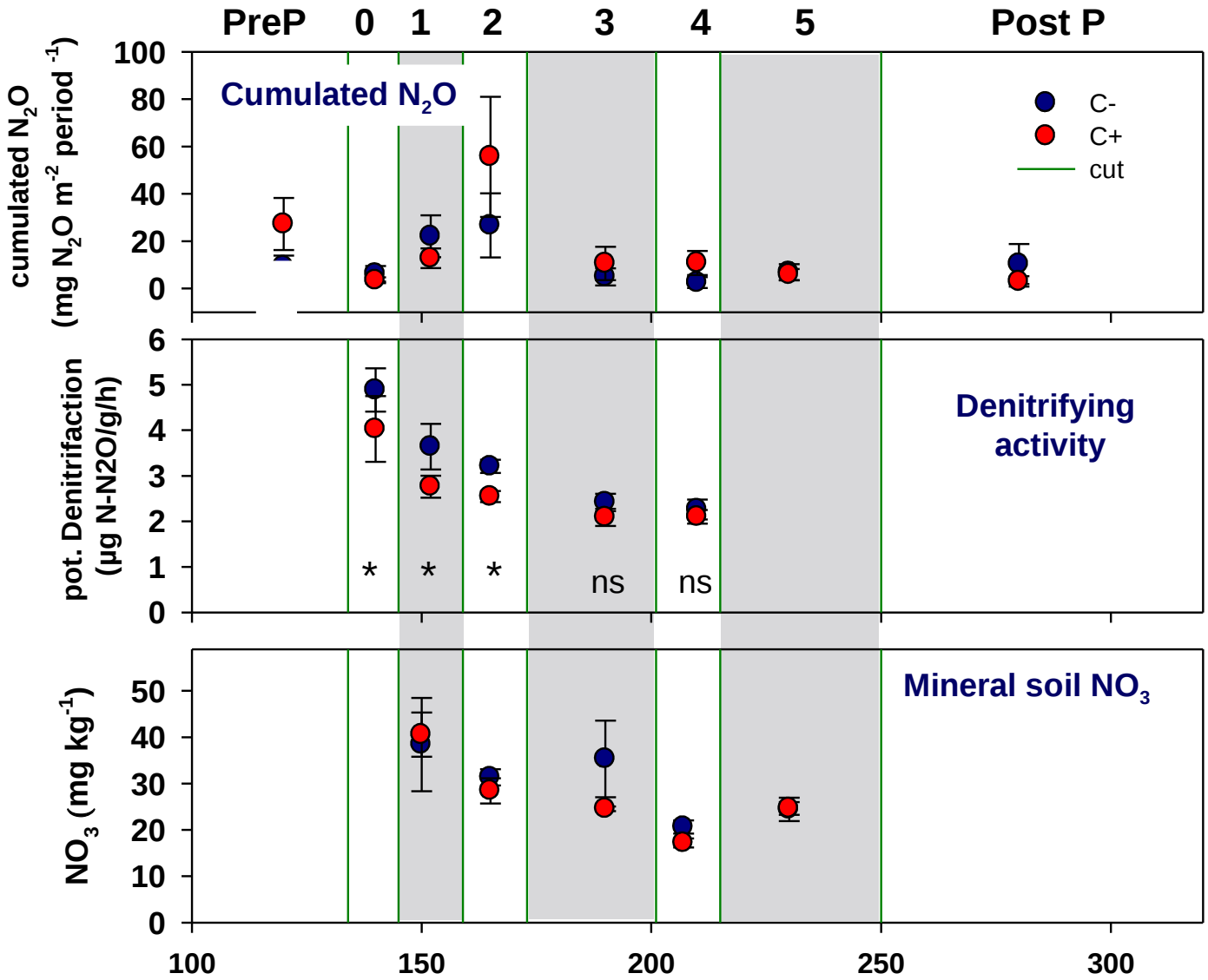
Period C+/C-

Period C+

Cumulated C- = 107±11mg N_2O m^{-2} (EF 0.015)

Cumulated C+ = 130±10mg N_2O m^{-2} (EF 0.018)

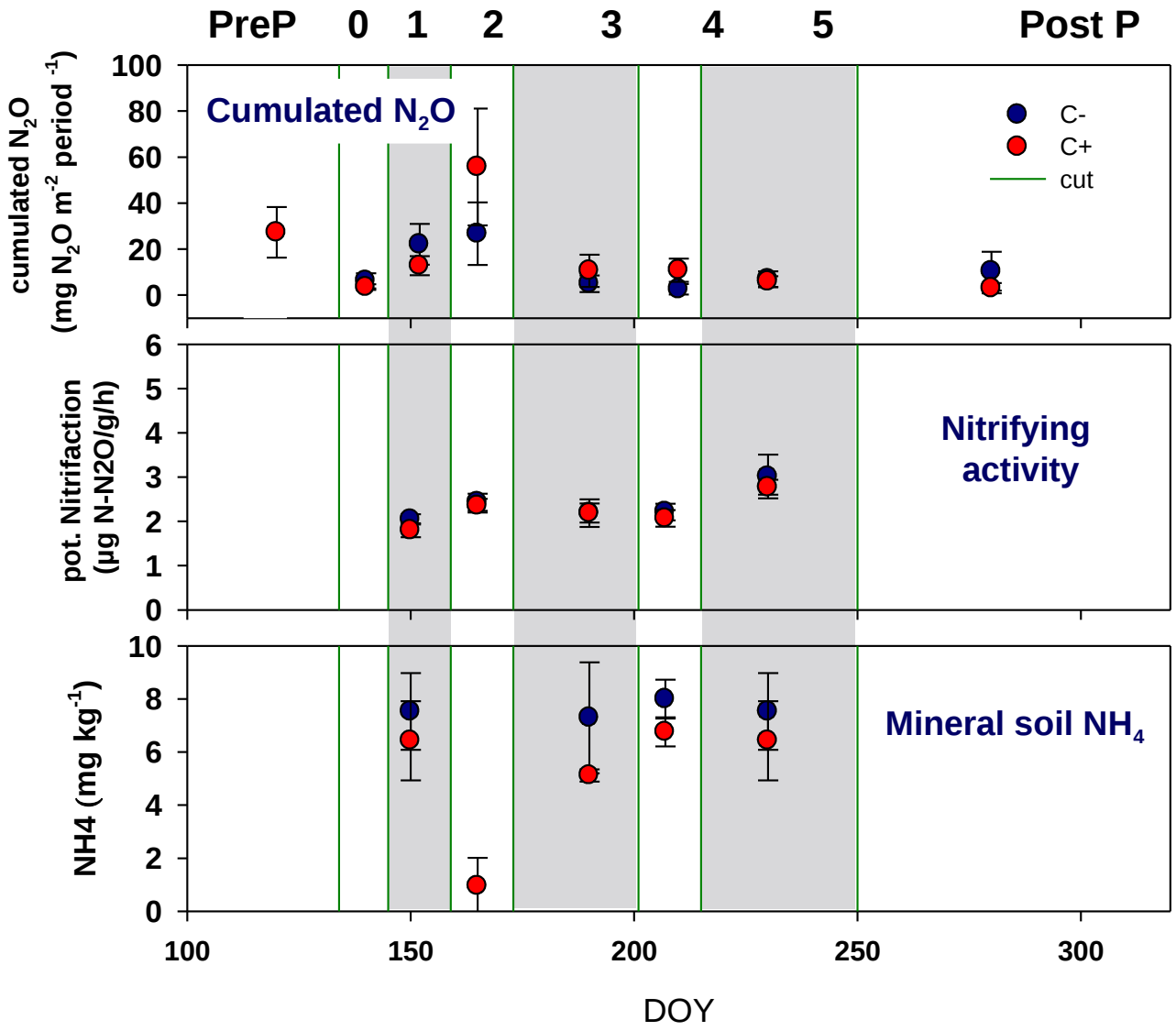
Results: cumulated N_2O flux and microbial activities



potential N_2O emission by denitrifying activity

↗ C- due to better NO_3 availability

Results: cumulated N_2O flux and microbial activities

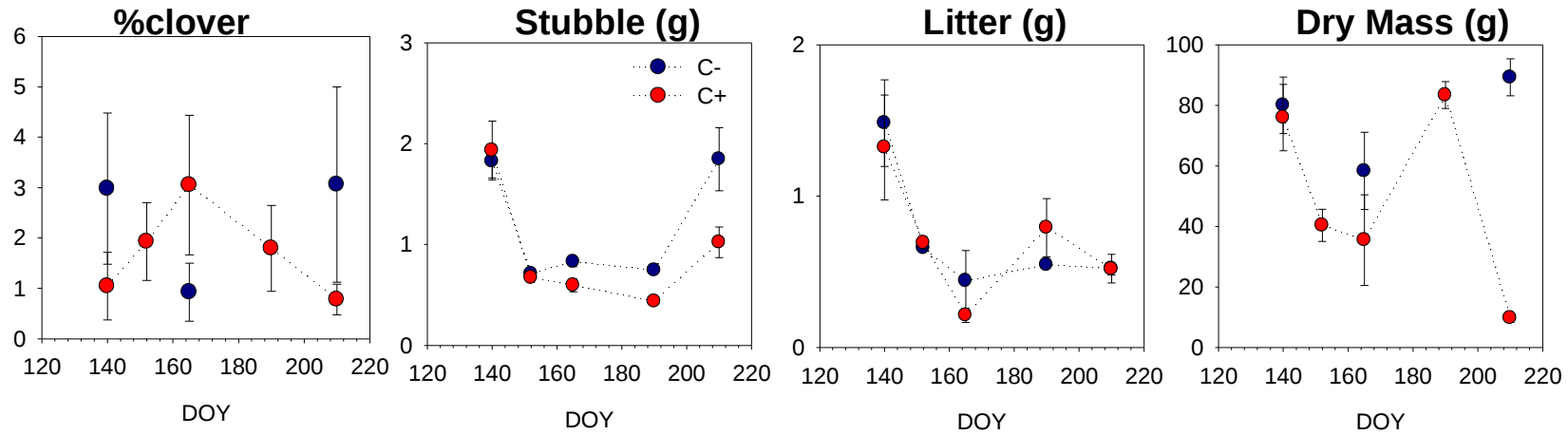


potential N_2O emission by Nitrifying activity showed no effect

↗ NH_4 availability in C-

Results: Microbial activity and other data

- Potential denitrifying activity increased with litter and green stubble mass and NO_3 ($p<0.05$, $R2=0.80$)



Except for %clover in period 2,3 and 4

C+ < C-

- **C+** Denitrifier activity was negatively related to mean N_2O emissions over the periode

($p<0.05$, $R2=-0.68$)

C+ Denitrifier activity was positively related to %clover

($p<0.05$, $R2=0.58$)

Results: N_2O emissions and other data

Forward stepwise multiple regression analyses

$Lg\ N_2O = -0.34\ DMass - 1.8\ NH_4 - 1.1\ stubble + 0.8\ NO_3 - 0.94\ Denit - 0.45\ pH$

(p-model< 0.001, R2=0.62)

- C+ $Lg\ N_2O = -1.2\ Litter - 0.8\ \%clover - 0.9\ NH_4$

(p-model< 0.01, R2=0.72)

Conclusions

- **C+** tended to have higher N_2O emissions probably due to higher clover fraction (i.e. N rich substrate) and labil C through cuts (3 out of 5 cut events).

- However, on annual basis this was out leveled due to other flux favouring variables (i.e. WFPS).

  (**C-** 107±11; **C+** 130±10 mg N_2O m^{-2})

- Our results indicate that not only amount and timing of N supply plays a role but also timing and frequence of defoliation.

Thank you